**The University of Michigan • Office of Research Administration**
**Ann Arbor, Michigan**

05863-3-P

March 20, 1964



National Aeronautics and Space Administration
Office of Grants and Research Contracts
Code SC
Washington, D.C. 20546

Attention: Dr. T.L.K. Smull, Director

Gentlemen:

This is the third in a series of quarterly status reports on Contract No. NASr-54(03) covering the period August 1, 1963, to October 31, 1963.



Introduction

The project effort during this work period was distributed between the tasks listed below:

a. Laboratory testing of the four radiation measuring instruments which were flown on the June 26, 1963, balloon flight.

b. Construction and testing of equipment for the aircraft flight tests of the NIMBUS MRIR and HRIR radiometers.

c. Analysis of data obtained on the June 26, 1963 balloon flight.

d. Study of methods of analyzing data obtained on the "Kaplan" experiment.

e. Study of stellar refraction as a meteorological satellite technique.



1. Laboratory Testing of the Four Radiation Measuring Instruments

Additional calibrations of the thermal channels of the NIMBUS No. F-1 MRIR radiometer were made both at Michigan and at NASA Goddard Space Flight Center. To date, there have been six separate sets of complete or spot check calibrations of the thermal channels of this radiometer. A chronological summary of these calibrations and other significant events follows:

November, 1962 - Initial Santa Barbara calibration.
May-June, 1962 - Initial U of M calibration.
June 17, 1962 - Disassembled radiometer and replaced chopper bearings.
June 19, 1962 - Santa Barbara spot check recalibration.

June 26, 1962 - Balloon flight test, partial in-flight calibrations.
August, 1962 - Second U of M calibration.
October, 1962 - NASA calibrations.

In each of the sets of calibrations, a partial check is also obtained when the radiometer scans over the housing and thus measures the housing temperature. This partial check is good for a given channel only when the radiometer housing temperature lies in the range of temperatures measurable with that channel. Usually the housing temperature is above 0°C and so is directly measurable only for channels II and IV. It may be possible to calculate the housing temperature from channel I data obtained at the time that the "sync." pulse is applied and the radiometer is looking at its housing, however this analysis has not yet been completed satisfactorily.

The in-flight calibrations obtained during the balloon flight consist of the housing temperature measurements described above plus "black-body" calibrations obtained at regular intervals throughout the flight. Since the "black-body" temperature was quite high while the balloon was at altitude, only channels II and IV were calibrated in this fashion.

The net result of all of this calibration work, is a disagreement between data obtained at the three locations. Data obtained at Santa Barbara disagree with Michigan and NASA data, and Michigan and NASA data also disagree. In general the several sets of data obtained at each location are self-consistant.

The data for channel IV are an exception to the above general statement. Excellent agreement was obtained for all except very low target temperatures (-70 to -90°C). The housing and black-body temperature measurements are also in good agreement with the calibration data.

For channel I the calibration data obtained at the three locations is in agreement only for radiometer temperatures equal to normal room temperatures. For radiometer temperatures greater or less than room temperature, the disagreement between the three sets of calibration data is a function of target temperature. The magnitude of the disagreement is greatest for very low target temperatures. Housing and black-body temperature checks have not been obtained.

The three sets of channel II calibration data disagree for almost all radiometer and target temperatures. Housing and black-body temperature readings obtained during the balloon flight test generally lie between results obtained at Santa Barbara and Michigan. In some instances this puts them in agreement with the NASA calibration data.

The evidence thus accumulated appears to have only one possible explanation,

that the thermisters which generate a signal compensating for variations in chopper temperature are not functioning properly. This would be possible, if the temperatures of these thermisters were influenced by housing temperatures as well as chopper temperatures. Since the calibration apparatus used at each of the three calibration sites is different having different cooling arrangements for targets and radiometer, it is probable that temperature distributions across the radiometers exist and that they are different in the different calibration set-ups.

Post-flight calibrations of the modified Perkin-Elmer SG-4 spectrophotometer were carried out. Wavelength calibrations were made first, using Osram mercury, cesium, rubidium, and potassium vapor lamps. The results are quite satisfactory. It is believed that an accurary of about 1% is obtained.

The responsivity of the instrument was measured for various detector temperatures by several methods. Although pre-flight and post-flight calibrations with a given method are consistant, measurements made with different methods do not agree. Also laboratory and in-flight calibrations do not agree.

This problem of the SG-4 calibrations again points up that our methods of visible radiation calibrations are unsatisfactory. Our calibrations of the visible channels of the TIROS 5-channel radiometer and of the NIMBUS MRIR are also somewhat in doubt.

Additional work was done on the calibration of the interferometer. An attempt was made to calibrate the instrument in a vacuum. The results were not very good because of noise introduced by the vacuum pump. After several trial runs, the transformer used in the dc to dc converter shorted. It has been decided that this type of calibration is not needed for interpretation of the balloon flight data, and so it will not be completed.

2. Aircraft Flight Tests of the NIMBUS MRIR and HRIR Radiometers

Construction of the aircraft flight test instrument package and of its electrical control and recording circuitry were completed. A radiation target was built for use in the wind-tunnel tests of the aircraft instrument package. In October, ITT completed modification of the HRIR instrument and the unit was delivered to our laboratory following an inspection and a one-day training session for our engineers at ITT. The final system check-out was underway as of the end of this work period.

3. Analysis of Data Obtained on the June 26, 1963, Balloon Flight

The analysis of data from the June 26, 1963, balloon flight continued. An

accurate trajectory based on ground photographs was plotted. The photocell data and camera photos were analyzed for gondola azimuth angle.

The TIROS radiometer channel II data was converted to equivalent black-body temperature. The data are presented in the form of graphs each containing data for an approximate 50-second interval. There are seven 50-second data intervals for each 15 minutes of flight time. For six of these intervals, the radiometer was looking downward at an angle of 30° to the vertical. For the seventh interval data were taken while the radiometer scanned from horizon to horizon on a 120° included angle conical scan. The unfiltered channel II radiometer output data is sampled at the rate of 10 samples per second. The running average over a half-second interval is plotted as a function of time.

Programs for sampling and analysis of the NIMBUS MRIR data have been prepared and are being checked out.

Approximately 50% of the interferometer data for this balloon flight have been analyzed. Data are presented as equivalent black-body temperature vs. wavelength at various times during the balloon flight.

4. Study of Methods of Analyzing "Kaplan Experiment" Data

Calculations are being made to investigate errors in the "library" method of solution of the "Kaplan experiment." A least square method of solution, modified by consideration of the eigenvalues and eigenvectors of the matrix equation, is being used. Preliminary results indicate that with realistic radiation data, quite different temperature profiles are essentially indistinguishable from one another.

5. Study of Stellar Refraction as a Meteorological Satellite Technique

Work continued on refraction primarily in the area of error analysis. The computer program written to give refraction angle as a function of tangent height in an arbitrary atmosphere was found to be erroneous in the case of model atmospheres having discontinuities in the temperature gradient.

A correlation of this error with the actual physical situation showed the problem to be a mathematical one in the sense that the real atmosphere was not properly represented by the model in the regions of discontinuities. However, to complete the analysis models having continuous density and density gradient will have to be utilized.